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BASELINE
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FACILITY OPERATING PROCEDURE

ED27 / Vibration, Acoustics, and Shock Team

Annual Calibration of Microphones

**CHECK THE MASTER LIST—
VERIFY THAT THIS IS THE CORRECT VERSION BEFORE USE**

Status (Baseline / Revision / Canceled)	Document Revision	Document Date	Description
Baseline		2/23/00	Document created.

1.0 INTRODUCTION

1.1 SCOPE

This procedure defines the steps required to conduct annual calibrations of microphones used by the ED27 acoustic laboratory.

1.2 PURPOSE

This document defines calibration procedures as required by MPG 8730.5.

1.3 APPLICABILITY

This procedure applies to the use of the Bruel and Kjaer (hereafter “B&K”) Type 9714 Customized Calibration System, and assumes general knowledge of the techniques of conducting acoustic measurements with microphones.

2.0 DOCUMENTS

2.1 APPLICABLE

ED27-VIB-SOP-001, Control of Quality Records in Vibration East

Vendor-supplied instruction booklet, Technical Documentation – Customized Calibration System Type 9714

2.2 REFERENCE

MPG 8730.5, Control of Inspection, Measuring, and Test Equipment

3.0 DEFINITIONS

None.

4.0 INSTRUCTIONS

The steps involved in the calibration of a microphone are (1) determination of open circuit sensitivity of the microphone, (2) determination of the frequency response of the microphone, and (3) documentation of the results. This procedure will allow accomplishment of all of the above.

4.1 REQUIRED EQUIPMENT

Mfg	Model	Description
B&K	2133	Dual Channel Real-Time Frequency Analyzer
B&K	2706	Power Amplifier
B&K	2669B	½" Microphone Preamplifier (2 needed)
B&K	2670B	¼" Microphone Preamplifier
B&K	4180	½" Laboratory Standard Microphone **
B&K	4180	½" Standard Verification Microphone **
B&K	4133	½" Verification Microphone **
B&K	4135	¼" Verification Microphone **
B&K	WA0817	Comparison Coupler
B&K	UA1284	Microphone Stand
B&K	UA0033	Electrostatic Actuator
B&K	WB0736	Electrostatic Actuator Supply
B&K	WT9571	Autosequence diskette
B&K	WT9571	Macro diskette
Microsoft	Excel	Spreadsheet for result documentation
Various	Various	Cables, adapters, etc. for interconnections

** with current and traceable calibration

4.2 SETUP ACTIVITIES AND INITIAL CONDITIONS

4.2.1 Electrical equipment should be powered up at least 30 minutes prior to use.

4.2.2 Ambient acoustic noise should be no greater than typical office levels (50-70 dB).

4.2.3 One blank, formatted 3 ½" low density (720 KB) data diskette is needed, with files "A_ACT.CMS", "A_REFSIG.CMS", "A_SENS2.CMS", "A_SENS4.CMS", "D_SENS2.DSU", "D_SENS4.DSU", "M_SENS2.MSU", and "M_SENS4.MSU". These are B&K 2133 autosequence setup files and can be found in the B&K 9714 documentation notebook. During the calibration session, reading result data files will also be copied to this diskette.

4.2.4 A printout of the calibration worksheet is needed. This worksheet is found in the Excel file "CalWorkSheets" and can be found in the B&K 9714 documentation notebook.

4.3 SENSITIVITY DETERMINATION

4.3.1 Execute “reset 9” on the B&K 2133 to clear all previous data.

4.3.2 Ensure validity of the sensitivity determination setup by carrying out steps 4.3.3 to 4.3.15 using a verification microphone (these steps are to be carried out once per calibration session).

4.3.3 Set B&K 2706 gain to MIN (fully counterclockwise).

4.3.4 Set up equipment as shown on page 6-26 of the B&K 9714 technical documentation.

- Connect B&K 2706 input to B&K 2133 generator output, B&K channel A direct input, and B&K channel B direct input.
- Connect B&K 2706 output to B&K WA0817 input.
- Connect B&K 4180 (standard microphone) to B&K 2669 to B&K 2133 channel B preamp input.
- Connect B&K 4180 (verification microphone) to B&K 2669 to B&K 2133 channel A preamp input.
- Insert both microphones into the B&K WA0817.

4.3.5 Allow five minutes for the microphones to warm up.

4.3.6 Set B&K 2706 gain to MAX (fully clockwise).

4.3.7 Insert the 3 ½” data diskette in the disk drive of the B&K 2133.

4.3.8 Recall B&K 2133 data file “A_SENS2”.

4.3.9 Push B&K 2133 “r/s” to start the autosequence (a data file "CHDIFF" will be saved to the data diskette).

4.3.10 Fill out the calibration worksheet information except for the columns "File Name Actuator" and "Sensitivity Ratio [dB]".

4.3.11 B&K 2133 “start”.

4.3.12 Wait for the 250 Hz cursor reading to settle.

4.3.13 Enter the 250 Hz cursor reading on the calibration worksheet in the "Sensitivity Ratio [dB]" column.

4.3.14 Verify system integrity by comparing the experimentally determined verification microphone sensitivity to its known value on the cal sheet. The verification microphone sensitivity is determined by adding the sensitivity of the standard microphone and the value in the "Sensitivity Ratio [dB]" column for the verification microphone.

4.3.15 If the experimentally determined sensitivity of the verification microphone is within ±1.0 dB of the known sensitivity, the setup is OK and this procedure may be continued. If the experimentally determined sensitivity of the verification microphone is not within ±1.0 dB of the known sensitivity, something is wrong with the setup. Return to section 4.3 and repeat all steps.

4.3.16 Carry out steps 4.3.17 to 4.3.24 for each microphone to be calibrated.

4.3.17 Set B&K 2706 gain to MIN (fully counterclockwise).

4.3.18 Replace the verification microphone (or a previous test microphone) in the equipment setup with the microphone to be calibrated.

4.3.19 Allow five minutes for the microphone to warm up.

4.3.20 Set B&K 2706 gain to MAX (fully clockwise).

4.3.21 Fill out the calibration worksheet information except for the columns “File Name Actuator” and “Sensitivity Ratio [dB]”.

4.3.22 Push B&K 2133 “start”.

4.3.23 Wait for the 250 Hz cursor reading to settle.

4.3.24 Enter the 250 Hz cursor reading on the calibration worksheet in the “Sensitivity Ratio [dB]” column.

4.4 FREQUENCY RESPONSE DETERMINATION

4.4.1 Execute “reset 9” on the B&K 2133 to clear all previous data.

4.4.2 Ensure validity of the frequency response determination setup by carrying out steps 4.4.3 to 4.4.13 using a verification microphone (these steps are to be carried out once per calibration session).

4.4.3 Set up equipment as shown on page 8-26 of the B&K 9714 technical documentation.

- Connect B&K WB0736 actuator compressor output to B&K 2133 channel A direct input.
- Connect B&K 2133 generator output to B&K WB0736 oscillator input.
- Connect verification microphone to B&K 2669 (or B&K 2670) to B&K 2133 channel A preamp input.
- Connect ground cable from B&K WB0736 ground to UA1284 base.
- Place microphone in the UA1284.

4.4.4 Fill out the calibration worksheet information except for the columns "File Name Actuator" and "Sensitivity Ratio [dB]".

4.4.5 Allow five minutes for the microphone to warm up.

4.4.6 Remove protective grill from the verification microphone cartridge.

4.4.7 Ensure the 3 ½" data diskette is in the B&K 2133 disk drive.

4.4.8 Recall B&K 2133 file "A_REFSIG".

4.4.9 Push B&K 2133 "r/s" to start the autosequence (a data file "REFSIG" will be saved to the data diskette).

4.4.10 Recall B&K 2133 data file "A_ACT".

IMPORTANT! When connecting the electrostatic actuator UA0033 to a microphone and the actuator voltage supply WB0736, always follow the following steps:

1. Connect the interconnect cable to the UA0033.
2. Place the UA0033 on top of the microphone, ensuring that the glass feet on the UA0033 make good contact with the top of the microphone.

3. Connect the interconnect cable to the WB0736 actuator voltage output.

Failure to follow these steps properly can damage the microphone.

4.4.11 Connect B&K UA0033 to the verification microphone and the B&K WB0736 actuator voltage output.

4.4.12 Push B&K 2133 “r/s” to start the autosequence. The frequency response result is automatically saved in the data file “FILE01”.

4.4.13 Note result filename on the calibration worksheet in the "File Name Actuator" column.

IMPORTANT! When disconnecting the electrostatic actuator UA0033 from a microphone and the actuator voltage supply WB0736, always follow the following steps:

1. Disconnect the interconnect cable from the WB07364 actuator voltage output.
2. Carefully remove the UA0033 from the top of the microphone.
3. Replace the protective grid on the microphone cartridge.

Failure to follow these steps properly can damage the microphone.

4.4.14 Remove B&K UA0033 from the verification microphone.

4.4.15 Verify system integrity by comparing the experimentally determined verification microphone frequency response to its known value on the cal sheet.

4.4.16 If the experimentally determined frequency response of the verification microphone is within ±1.0 dB of the known value in each 1/3 octave band, the system is OK and this procedure may be continued. If the experimentally determined frequency response of the verification microphone is not within ±1.0 dB of the known value in any 1/3 octave band, something is wrong with the setup. Return to section 4.4 and repeat all steps.

4.4.17 Carry out steps 4.4.18 to 4.4.22 for each microphone to be calibrated.

4.4.18 Replace the verification microphone (or a previous test microphone) in the equipment setup with the microphone to be calibrated.

4.4.19 Allow five minutes for the microphone to warm up.

4.4.20 Connect B&K UA0033 to B&K WB0736 actuator voltage output and to the test microphone.

4.4.21 Push B&K 2133 “r/s” to execute the autosequence.

4.4.22 The result is automatically stored on the B&K 2133 data diskette ("file02" for test microphone #1, "file03" for test microphone #2, etc).

4.4.23 Note result filename on the calibration worksheet in the "File Name Actuator" column. A line for the test microphone should have been previously started during the sensitivity determination steps above.

4.4.24 Remove B&K UA0033 from the test microphone.

4.5 CALIBRATION CERTIFICATE

4.5.1 Start Microsoft Excel, open the spreadsheet “MicCal2133”. Click on the picture to begin.

4.5.2 With the B&K 2133 data diskette in the PC disk drive, enter data from the calibration worksheet into the spreadsheet as directed for each test microphone.

4.5.3 The calibration certificate is automatically created by the spreadsheet for each test microphone. In addition, calibration data can be saved under the microphone’s serial number in the spreadsheet’s database.

4.5.4 If the frequency response of any test microphone is greater than ±1 dB in any 1/3 octave band within the microphone’s usable frequency range, the microphone must be rejected.

5.0 QUALITY RECORDS

A backup copy of the calibration data files created by the Excel spreadsheet shall be maintained as a quality record, stored in accordance with ED27-VIB-SOP-001. New backups will be created following each calibration session.